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Country Economics Department
The World Bank
July 1989
WPS 229

The Effect of Demographic Changes on Saving for Life-Cycle Motives in Developing Countries

Steven B. Webb and Heidi S. Zia

Declining fertility and the transition to stable populations is likely to increase aggregate saving rates measurably. Saving for retirement will probably increase but not dominate total saving changes.

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If developing countries follow the same paths industrialized countries have followed, saving for retirement will initially become more important as the population growth rate declines.

To calculate the potential importance of life-cycle saving (saving for retirement), Webb and Zia set up a simulation model that translates demographic projections into savings-rate projections. Modeling explicitly the behavior of each cohort of households separates the effects of changing population shares of children and retirees. These shares behave differently and have different effects on saving as the population growth rate changes.

Baseline World Bank population projections assume that by the middle of the twenty-first century, if not sooner, the net reproductive rate of women in every country will decline to 1.0, a level that will eventually lead to a stable population. As the last cohort of those born in the years of high reproductive rates reaches adulthood, the proportion of working-age population rises sharply. Then, as baby boomers retire and die off, it declines toward the steady-state level.

Webb and Zia simulated aggregate rates for life-cycle savings for Brazil, China, Korea, Mexico, Nigeria, Pakistan, and Turkey.

The savings rates increase 5 or 6 percentage points when the last baby boomers enter the work force and begin to save after their children leave home. The effect on life-cycle saving is dramatic; the effect on total savings rates, which are often three or four times as high, is not.

Simulated life-cycle savings rates peak at an absolute 10 percent or less in all cases. The patterns in these projections seem robust with regard to assumptions about productivity growth, interest rates, and age-specific participation in the labor force.

This paper is a product of the Macroeconomic Adjustment and Growth Division, Country Economics Department. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Emily Khine, room N11-067, extension 61765 (27 pages with charts and tables)

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We have benefited from Jacques van der Gaag's suggestion of the simulation methodology and from comments by Bela Balassa, Vittorio Corbo and other colleagues in CECMG. We thank My T. Vu for helping us use the demographic projections.

Introduction

Rapid population growth in developing countries has been a staple concern of economists for decades, but we also need to think about what a slowdown and end to that growth will mean or would mean, for the end of it is not yet certain. This note focuses on the implications for saving behavior. We report simulations to see how the projected demographic changes would affect aggregate saving behavior for the life-cycle, consumption-smoothing motive. Our results imply that the demographic transitions, projected by demographers at the Bank and elsewhere, would increase aggregate saving in developing countries by around 5 percentage points of GDP. The timing of this saving increase depends, of course, on the timing of the demographic transition, but the sizes of the projected saving changes are remarkably similar across countries. These increases of saving are large enough to have a significant impact on the per capita growth rate, although they are smaller than the double-digit increases of saving rates in some countries with the most successful development in the 1980s. The projections of saving rates are not intended in any way as forecasts for the individual countries. They only illustrate what would happen to one type of saving behavior, namely household savings, in response to several variants of demographic transitions.

Many economists have written on the effects of demography on saving. Most commonly the empirical studies look at dependency ratios -- the share of the population under 15 or over 65 -- as one of the right-side variables in a regression with the aggregate saving rate on the left. The results vary according to the sample and the choice of other explanatory variables, but generally higher dependency ratios significantly lower saving rates (Leff 1969, 1971, 1980; Mason 1987; Mason and Fry 1982; Lahiri 1988; Rossi 1989; see Hammer 1986 for a survey). This empirical result is fully consistent with the model and simulations that follow.

The contribution of this study is to employ an explicit model of life-cycle saving to examine the effects of actual and predicted changes in demographic structure for particular economies. Explicit life-cycle models have been used to predict saving rates analytically, which has required the researcher to assume steady-state populations (Tobin 1967; Hammer 1987). Only with the numerical simulation procedures used here is it feasible to examine in detail the effects of the great deviations from steady-state that occur during demographic transitions. In the simulations shown below, the greatest fluctuations of saving rates occur when the population systems deviate farthest from steady-state.

Demographic Projections

Demographic forecasters predict hopefully that by the middle of the next century all the developing countries will have begun phase two of their demographic transitions, in which net reproductive rates (NRR) fall to 1. (The NRR is the number of female children per woman that survive to childbearing age.) Eventually, this will cause aggregate birth rates to

decline to equal death rates, but that will take many decades because previous population growth makes the share of women in childbearing age higher than the steady-state share. In South Korea, for instance, the NRR is now one, but the crude birth rate is over one percent above the crude death rate. If the NRR stays at 1.0, the birth rate will not equal the death until the 22nd century. In many countries of Europe, North America, and East Asia the net reproductive rates have already declined to near 1.0 or lower, and in most Latin American countries the declines are clearly underway. In most of sub-Saharan Africa and a few other places, on the other hand, the decline of net reproductive rates has not started and is projected mainly on the basis of extrapolation from other regions and of hope for declines in birthrates before dramatic increases of death rates become unavoidable.

The demographic transitions in the developing countries promise to be even more dramatic than those that took place over the past century in Europe and North America, because the birthrates have been higher absolutely and relative to the death rates. The age composition of the population in developing countries will change dramatically. In most developing countries, 40 to 50 percent of the population is currently under the age of 15, and less than 5 percent is 65 or older. In the projected demographic steady states, with birth rates at replacement rates, those under 15 will be less than 20 percent of the population and those over 65 will be over 10 percent. In between the current situation and the zero-population-growth (ZPG) steady states, countries pass through a phase where the share of children has fallen but the share of the old has not yet risen as much. The industrial countries are currently in that phase, and most of them have increased their saving rates, arguably in anticipation of sharp (further) increases of the share of

elderly.

Figure 1A shows the population profiles for Brazil, Nigeria, and Japan in 1985, and the projected profiles for Brazil in 2030, Nigeria in 2055, and both Brazil and Nigeria in 2100 (Figure 1B). Notice how the projected profiles for Brazil and Nigeria in the next century (when their simulated saving rates turn out to be highest) resemble that of Japan today.

Life-Cycle Saving

There are several important motives for saving that are related to demographic variables. This study focuses on saving to provide for one's old age, commonly referred to as life-cycle saving. During their working years, the story goes, people save enough so that they can sustain steady consumption after retirement by buying an annuity or living off the principal and interest of their investments. A later section discusses the details of modelling such behavior. Intuitively, one can see how a demographic transition will affect aggregate saving for life-cycle motives. If people do most of the saving for their old age in the working years after their children leave home, the economy's saving rate will rise when the cohorts that started having fewer children per woman (low-birth cohorts) reach the high-saving years. Prior to that time, the share of households in the high-saving age is small, leading to a low aggregate saving rate. Saving rates for the life-cycle motive peak when the first of the low-birth cohorts goes through the high-saving age, because the share of older people (negative savers) in the population is still small. Then the aggregate saving rates decline again somewhat, to the ZPG steady state, as the low-birth cohorts retire, raising the share of households that are negative savers. This note focuses on the life-cycle motive because that motive is most likely to produce a dramatic shift in saving as a result of the

projected declines in birth rates.

Motives for saving would probably change during the demographic transition. The experience of the industrial countries suggests that saving for housing, consumer durables, and education become more important during the transition. Let us consider briefly some of these influences on saving, which act along side the life-cycle motives for saving. (See Gersovitz 1987 for a survey.) The direction of causation of the demographic transition and non-life-cycle savings motives is not clear and is probably not in a single direction. Furthermore, the nature of households change during the transition.

Many people in developing countries today live in extended households that last beyond the lives of those in them, and probably most adults in them expect to rely mainly on their children for support when they reach old age. Thus actual saving for life-cycle motives would be lower today than in our simulations. With non-negative rates of population growth and interest, life-cycle saving rates for extended households would be lower than for the nuclear, mortal households (Gersovitz 1987). Parents who could expect to share in the earnings of their children would save less for their old age than parents who could not. In Gary Becker style home economics, parents who invest more in children as earning assets would invest less in financial assets. The Bank's assumption that all countries will make the transition to stable populations with low rates of birth and death seems to imply an accompanying transition to nuclear households, since that is what has predominated in the industrial economies that have already made the transition to stable populations. Furthermore, if <u>average</u> net reproductive rates sink to 1.0, a large fraction of the adults would face the substantial probability, if

not the certainty, of having no working children that could help support them after retirement. Other forms of old-age security would have to become the norm.

Besides the life-cycle motive, people might also save to make bequests at or near their death, to pay for their children's education, to accumulate assets to purchase consumer durables (including housing), or to take advantage of market returns in excess of their rate of time preference.

The bequest motive for saving would initially reinforce the life-cycle motive's effect of increasing aggregate saving during the demographic transition, because people would save for bequests also during the later working years. (As discussed later, for the purpose of smoothing per capita consumption over the life-cycle, parents would concentrate saving in the years after children leave home.) Determining the effect of bequests in the steady state would be complicated, however, by their effect on the behavior of households that receive them. In the initial condition of most developing countries it seems unlikely that inherited wealth (except land) would play a major role in consumption decisions of most households. Saving for bequests would increase the peak in the saving rates caused by the life-cycle motive, but later its effects would be mixed as the economy moved toward the steady state: retirees would dissave less, in order to preserve a legacy to bequeath, but with a slight delay working households would need to save less for their retirement as they started to receive larger inheritances because they had fewer siblings.

Parents' (or grandparents') saving ahead for the education of children (already born) would follow a predictable path through the demographic transition, if the strength of the education-of-children motive for saving

stayed constant. Saving for education would rise then fall along with the share of children in the population. Fluctuations in aggregate saving for education would in such a case tend to offset the changes of life-cycle saving during the demographic transition. On the other hand, if the education motive for saving strengthens as the children per household declines, then changes in saving for education would reinforce the changes in life-cycle saving. (See also Drazen, 1978.)

Saving for consumer durables motivates saving during the earlier years of a household's life, in the years with non-working children. More uniform saving over the life of a household would reduce any impact of the demographic transition on aggregate saving, since households would save at more nearly uniform rates over the working years, and the changing relative size of age cohorts would make less difference. Because of the high per-capita-income elasticity of demand for consumer durables, however, the demographic transition could still have a net positive effect on aggregate saving for consumer durables. Fewer children would raise per capita income and thus raise the demand and saving for consumer durables and children's education. In other words, when DINKs (couples with Double Incomes and No Kids), which are now rare in LDCs, become common (that's what the demographic transition means), they may behave like DINKs in industrial countries and save more for new cars and video equipment.

The demographic transition will not have a strong or clearly predictable impact on saving for motives other than life-cycle. With that in mind let us turn to the simulations, which aims to provide quantitative estimates of how much aggregate life-cycle saving will change during the demographic transition.

A Simulation Model for Household Saving

Households are the behavioral units of the model here. Therefore, first step is to construct a picture over time of the demographic composition of the typical household in each cohort (those started in a 5 year period, or pentad). The Population, Health, and Nutrition Division (PHRHN) has detailed demographic projections from which one can infer what typical households will look like for the next couple of centuries, given the PHRHN assumptions about the trajectory of fertility and mortality. We assume that the number of households in each cohort is the number of women in that cohort who have left their parents' household. There is thus one adult woman per household, and a cohort of households lasts as long as the life expectancy of the women. There are as many men per household of a cohort as there are men per women. Children enter the household at birth and phase out as young adults. We used fertility rates for different cohorts of women to allocate children of each cohort to the proper cohorts of households (of women).

Households in the model receive labor income and interest income from any accumulated saving. The base-line interest rate is 3 percent (real). People enter the work force starting at age 15, and they leave at 65. Participation rates are 0.8 for ages 15-19 (for the 30 percent of young persons that have separated so early from their parents), 0.7 for 20-60, 0.6 for 55-69 and 0.4 for 60-64. Productivity and wages of the standard worker grow each year, 3 percent per year in the base-line case. Young workers earn less, 50 percent of the standard for ages 15-19, 60 percent for ages 20-24, and 80 percent for ages 25-29. Teenagers at home were assumed to make no income contribution to the household in the base case. After the age of 30, all workers earn the same amount in any given year, although a worker will

earn more over his lifetime than his father or older brother, because productivity growth makes the standard wage higher over his lifetime. Because men and women are merged within each household, there is no point is distinguishing between their productivity or participation rates.

For a given interest rate and growth rate of labor productivity, each household saves (and dissaves) in order to smooth per capita consumption as much as possible. We assume that households start with zero net wealth, that households plan to have zero wealth when the parents die at the expected age of death for their cohort, and that households cannot be net debtors in any period. Assuming that consumption cannot exceed income for young households is not entirely realistic, but it seems preferable to the other equally simplifying assumption, namely that households can borrow as much as they want to smooth per capita consumption of the households. Assuming no liquidity constraint would lead households in the simulation to run up debt several times their annual earnings, which seems less realistic than assuming no debt.

With this set of objectives and constraints, households consume all their income (all from labor) until the parents reach their 40s because, relative to the expectations for later years, labor productivity is low and especially because the household population per worker is high. The households turn to saving when the parents are in their forties, early or late depending on parameters such as the rate of assumed labor productivity growth and the numbers of children. Figure 2 shows the path of income, consumption and wealth for a typical household. An iterative program (LOTUS macro) tried different transition points from saving to non-saving and different constant levels of constant per capita consumption after the switch to positive saving,

until a consumption path was found that left zero wealth at age 75.[1] In this manner we simulated the income, consumption and saving of each cohort of households, starting at the beginning of the 20th century and going out to the end of the 22nd century.[2] In order to do the aggregation for any period, say 1950-54 or 2085-89, it was necessary to have the income and consumption paths for every cohort of households that existed in the period.[3]

To get the aggregate saving rate of the economy for each 5-year period, we multiplied the income and consumption per household for each cohort by the number of households (women) in the cohort during the period. Then we added up the income and consumption across households.

Simulation Results

The paths of consumption for households did not change greatly over the transition. Most of the change in the aggregate saving rate resulted from the changes in the relative numbers of different age households.

Figures 3 to 9 show the simulated saving rates with base-case assumptions for Brazil, China, S. Korea, Mexico, Nigeria, Pakistan, and Turkey. The saving rates are all in the range of 3 to 11 percent, which is

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[1] A point of imprecision in the simulation is that the wealth of households that die early just disappears and is not available for consumption by the survivors.

[2] Since UN population data with the requisite breakdowns by age start only in 1950, we had to project the earlier history of all households that were still existing in 1950. This was necessary to have simulations of aggregate saving that began in the 1950s. Without some back projection we could not have computed any aggregate saving rates for years before 2010. For the pre-1950 projections we assumed the age-specific death and fertility rates that prevailed in 1950. Our results are not sensitive to these assumptions.

[3] The unit of income and consumption was the annual earnings of one full adult worker in the base period (1980-84).

plausible, in that we are considering only household saving and only for one motive.

The simulated saving rates rise, as our intuition suggested. The sharpness of the rise depends on the rapidity of the decline in the fertility rate. The size of the rise is almost uniformly 5 percentage points from the 1980s to the peak in the next century. The rises for China and Mexico are the steepest and are 6 percentage points. They are so steep because of the size of the recent and projected decline in the Net Reproductive Rate. Since the changes took place in less than one generation, the demographic structure and aggregate saving projections show an echo of the transition long after the NRR has stabilized at 1.0. This is especially pronounced for China. (Such patterns really happen; French demography echoes the Napoleonic wars through the whole 19th century). The timing of the rise in the saving rate depends on the date of the projected or actual decline in fertility. The note to each figure indicates the date by which the net reproductive rate (NRR) is assumed to reach 1.0.[4] In China and Korea, for instance, the drop of reproductive rates per woman to NRR = 1.0 has already occurred, although population will continue to grow for some time, due to the increasing numbers of women of childbearing age. In Nigeria, where the slowdown of births has not begun and where the population projection does not assume a NRR of 1.0 until 2035, the saving rate drifts down for 20 more years before turning upward and moving toward a peak in 2050.

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[4] With a net reproductive rate of 1.0, population growth eventually stops.

Sensitivity to Assumptions

The results illustrated in the base cases are worth taking seriously only if they do not depend critically on the assumptions used in the simulations. We chose Brazil as a case to test the results for sensitivity to the assumptions about the interest rate, productivity growth rate, age of entry of youths into the workforce, and age of retirement.

Since the model is all in real terms, the relevant interest rate for these long-term projection is presumably a positive rate less than 10%. It is the real rate of return on assets held by the household after it starts to save. Figure 10 shows the projected paths of saving rates with 1 and 5 percent interest, as well as 3 percent, which is the base case (also shown in Figure 3). With the life-cycle saving motive, the interest rate changes have only an income effect, which is small, lowering the saving rate by less than a percentage point for each percentage point rise of the interest rate rises. Changing the interest rate does not affect the projected pattern of the response of the saving rate to the demographic transition.

The growth rate of labor productivity makes little difference for the aggregate saving rate in the early years, and there is never much difference between aggregate saving rates with 3 percent and 6 percent annual productivity growth. With zero productivity growth, however, simulated aggregated saving drops sharply as the demography moves toward the steady state. The impact of slow productivity growth is distant but it does convey some intuition about the relation of productivity and life-cycle saving. When productivity is growing, the aggregate impact of dissaving of retirees is mitigated by the growth in labor income of younger cohorts. With 6 percent productivity growth, retirees in their 70s are enjoying a life-style (paid for

out of saving) that is only about half as expensive as the life-style (and saving) of those still working. With no productivity increase, on the other hand, the dissaving retirees weighs heavier on the economy. Obviously, this effect is unimportant before the time when retirees are a large share of the population. Figure 11 shows the projections for Brazil with zero, 3, and 6 percent annual productivity growth (and 3 percent interest, as in the base case).

The ages at which people enter and exit the workforce affects both the level of the saving rate and the strength of the effect of the demographic transition, but reasonable variation in the assumptions about the life-cycle of work effort do not qualitatively change the results for the impact of the demographic transition. Figure 12 shows saving rates with a labor participation rate of 0.5 for 15-19 year olds still living with parents and with labor participation zero for them (the base case). With teenagers working, parents can start sooner to save for their old age, but they do not need to save as high share of income in their 50s. The demographic transition starts to push saving rates up a little sooner, and the peak is less pronounced, but there is no discernable impact in the steady state.

Figure 13 shows the effects of assuming earlier or later retirement. Assuming fewer post-retirement years means people need to save less to support themselves then. Varying the retirement age has a substantial effect on the level of the saving rate, but not on the changes caused by the demographic transition.

A simplifying assumption in our model was that all members of the household consumed the same amount. In fact, children in developing countries consume less than adults. Also, it seems intuitively and empirically that

households everywhere have economies of scale in the sense that it costs less to provide four people a certain level of welfare when they are living together than when they live separately. Consequently, if the household is trying to smooth per capita utility as much as possible over the life cycle, it would reduce per capita consumption expenditures when the household was large (children still at home) in order to save more for consumption when the household is small. These considerations would lower the age at which households stop consuming all labor income and start to save. In practice, however, the effect would be negligible, if there was at least moderate growth of labor productivity and the no-borrowing constraint. Even if children needed only half as much consumption as adults (combining age and economy-of-scale effects), the age on the onset of saving in our model would not change by more than 5 years.

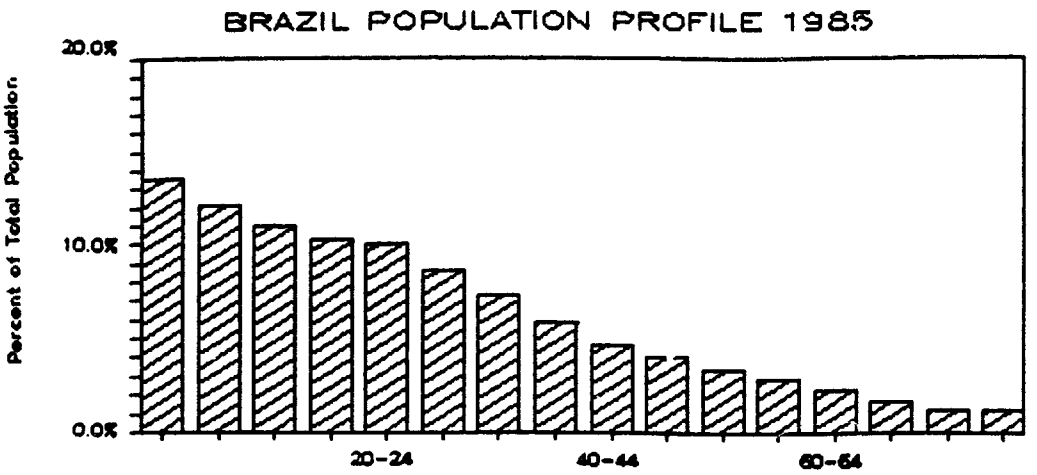
Conclusions

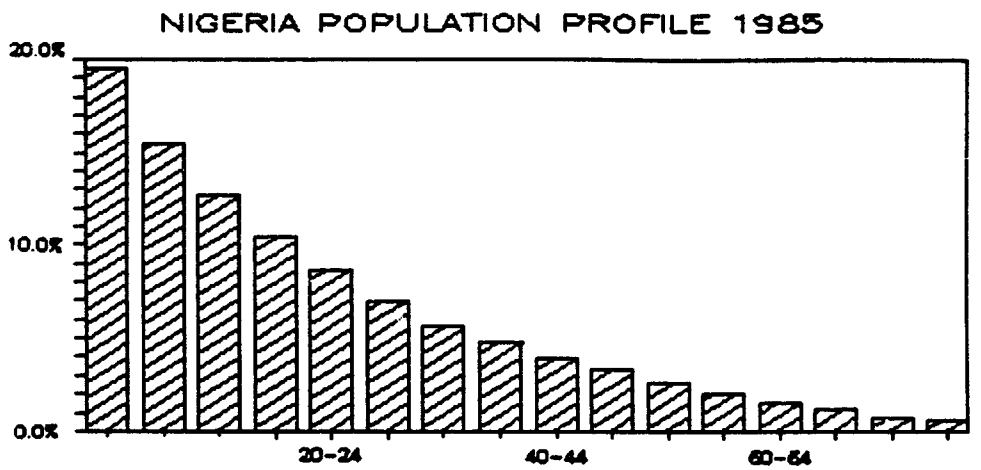
The exercises reported here are mainly suggestive of the importance of the demographic factors for aggregate saving and macroeconomic phenomena in general. The demographic transition toward stable populations is likely to cause increases of aggregate saving rates that would be important on a macroeconomic level. With some plausible assumptions, the demographically induced changes of saving rates would be comparable in size to the changes governments could hope to induce by policy changes. Indeed, policy changes would often be necessary in order to get people to save for their old age as completely as is assumed in the simulations. For countries that have already begun to experience declines of fertility, increases of life-cycle saving would come soon enough to be relevant for repaying debt incurred in the 1980s.

They would probably not, however, be the dominant force in the determination of overall saving.

Demography is crucial to long-run macroeconomic analysis, and the life-cycle household saving relationship is only one of many important links. For instance, the demographic transitions would radically alter the per capita labor force and income. Economic demographers may wish to try to model the circular links from demography to saving, as done here, from saving to income growth, and from income growth to saving.

FIGURE 1A


BRAZIL POPULATION PROFILE 1985
Percent of Total Population
20.0%
10.0%
0.0%
20-24
40-44
60-64


NIGERIA POPULATION PROFILE 1985
20.0%
10.0%
0.0%
20-24
40-44
60-64

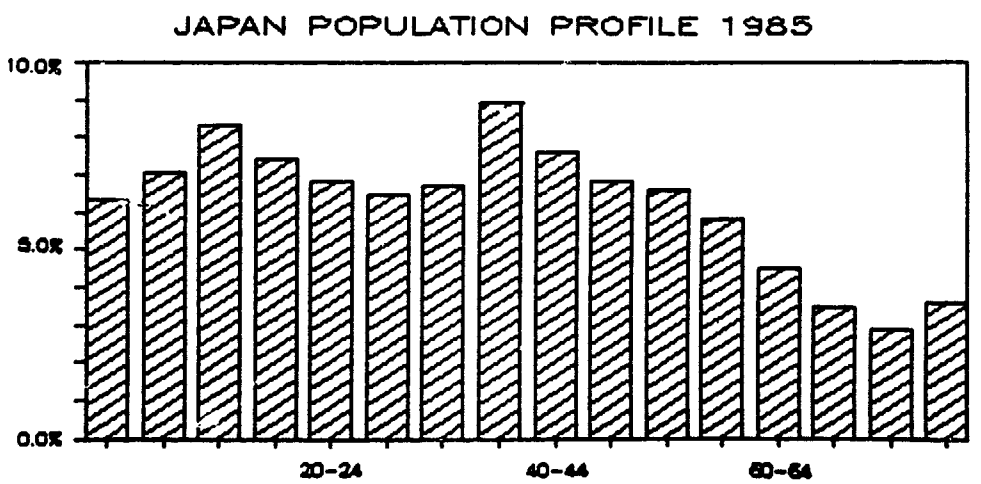
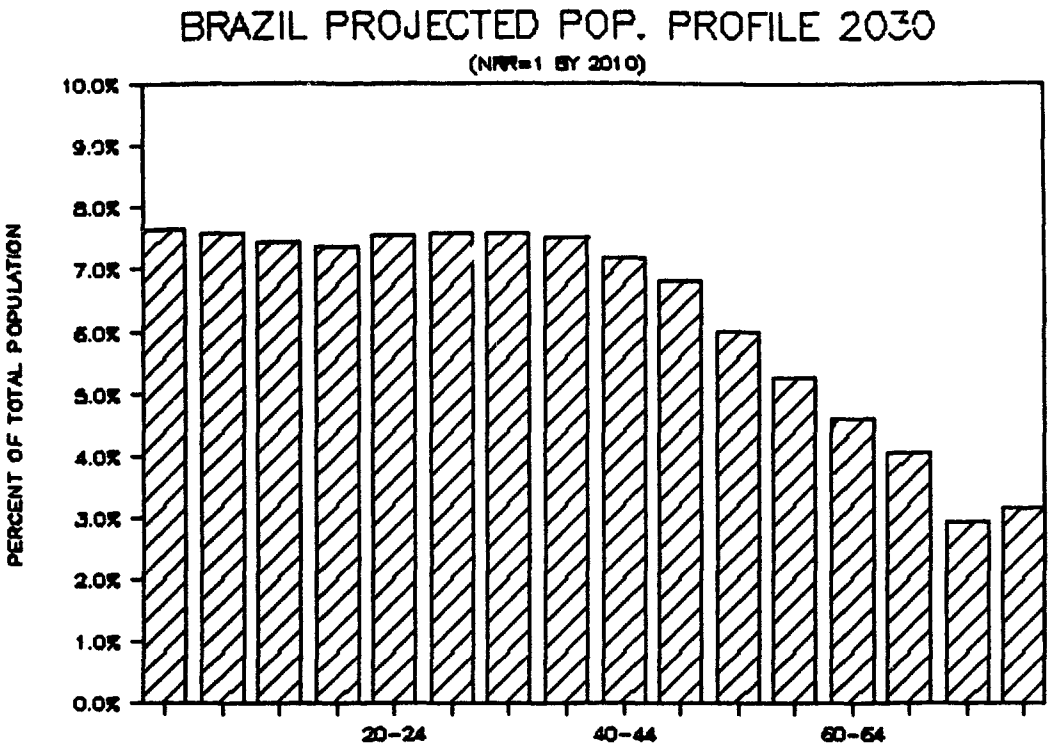

JAPAN POPULATION PROFILE 1985
10.0%
5.0%
0.0%
20-24
40-44
60-64

FIGURE 1B


BRAZIL PROJECTED POP. PROFILE 2030
(NRR=1 BY 2010)
PERCENT OF TOTAL POPULATION
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
20-24
40-44
60-64

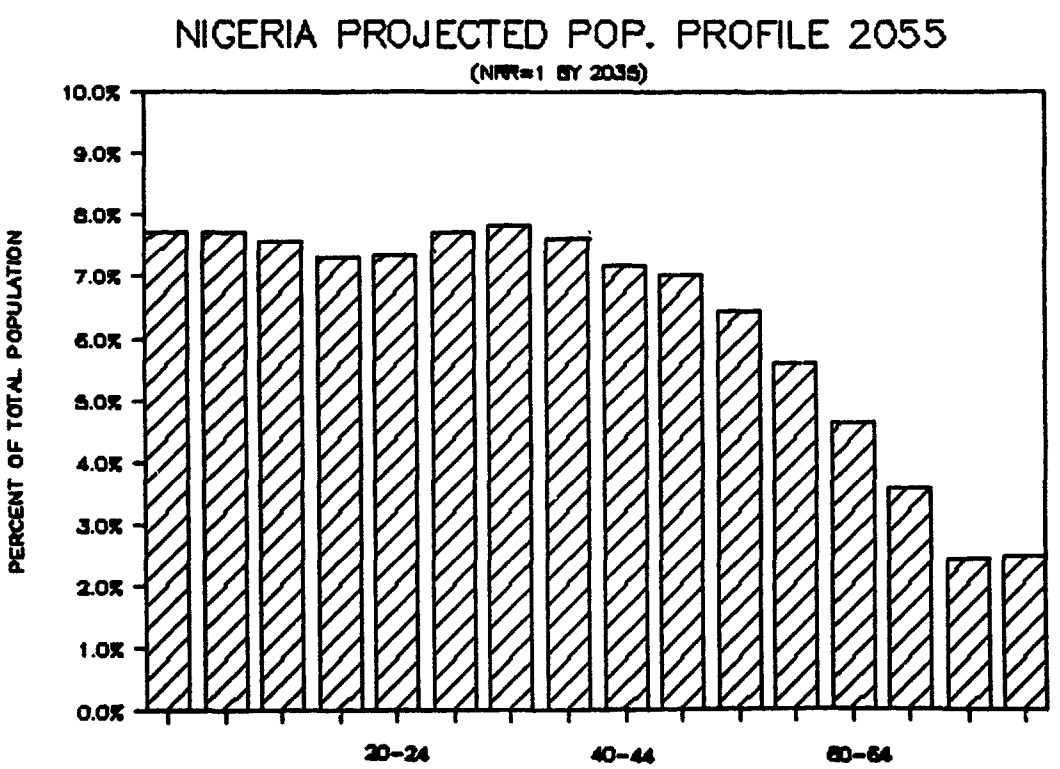
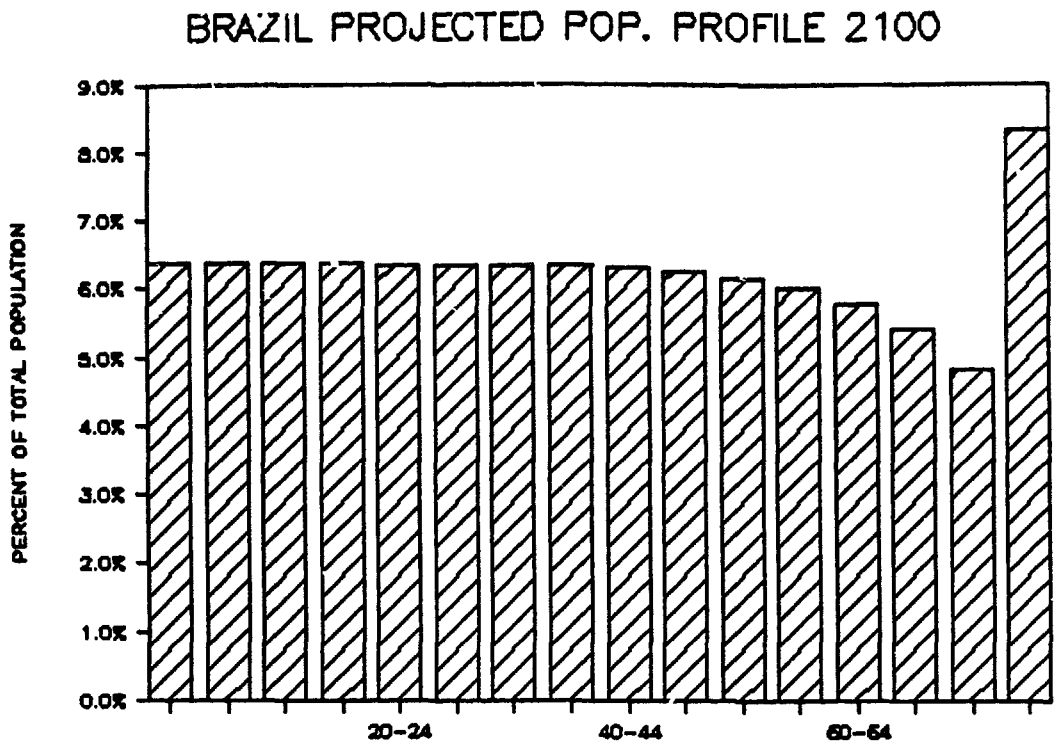

NIGERIA PROJECTED POP. PROFILE 2055
(NRR=1 BY 2035)
PERCENT OF TOTAL POPULATION
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
20-24
40-44
60-64

FIGURE 1B (cont'd.)



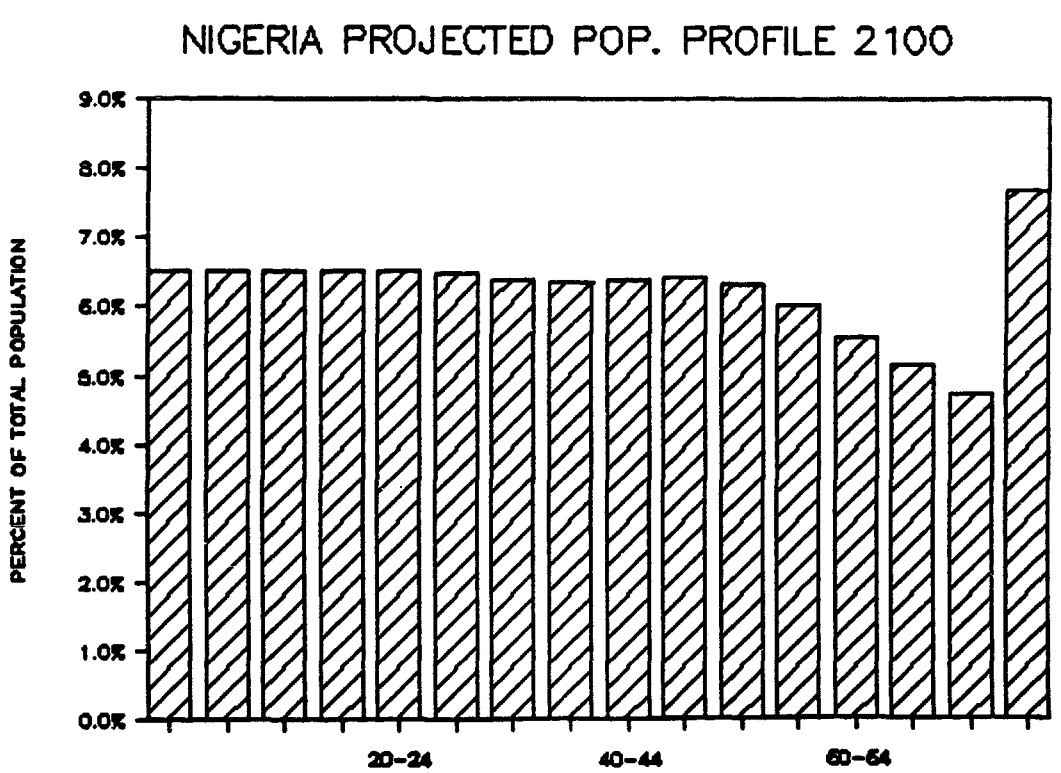
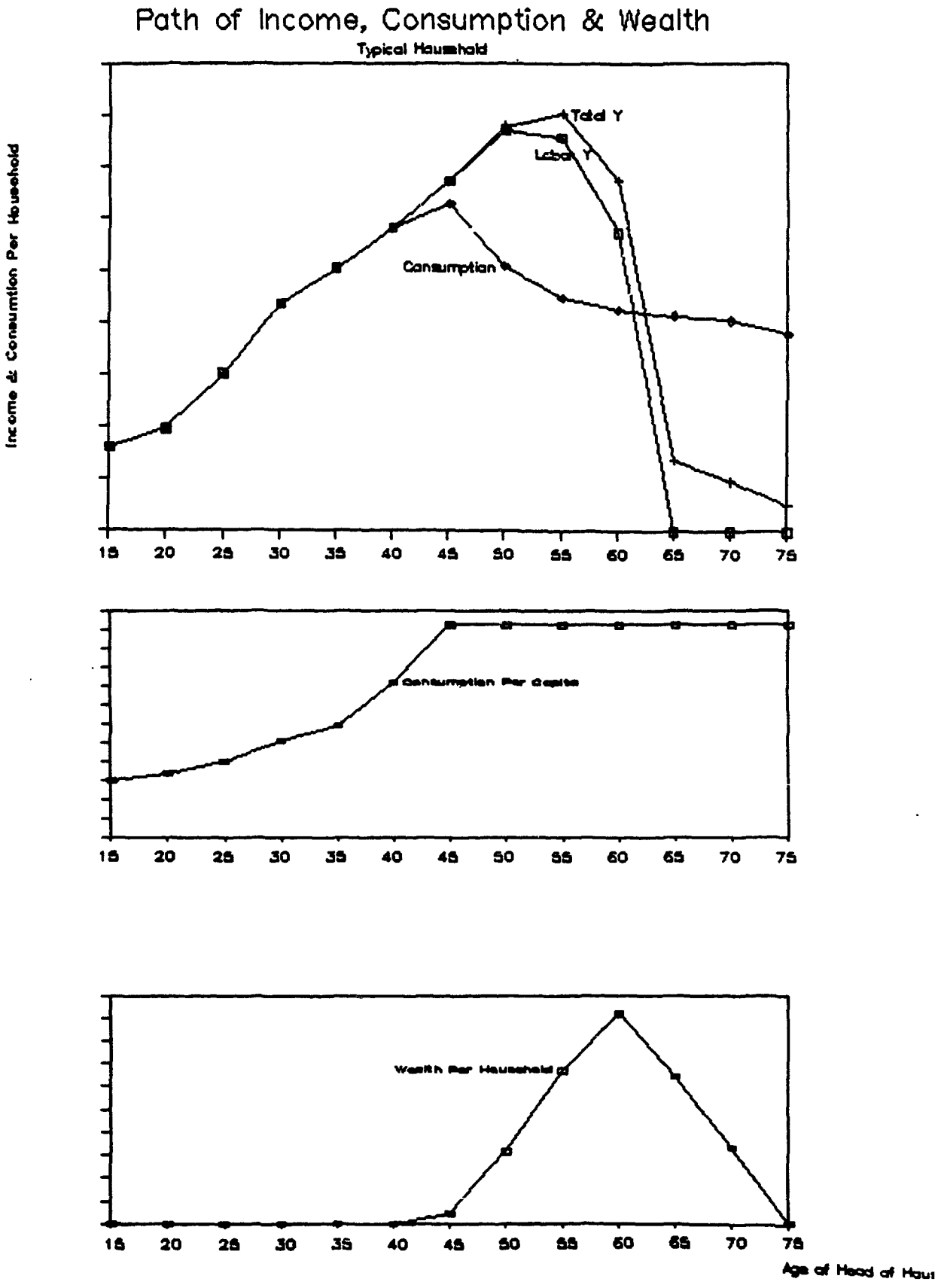
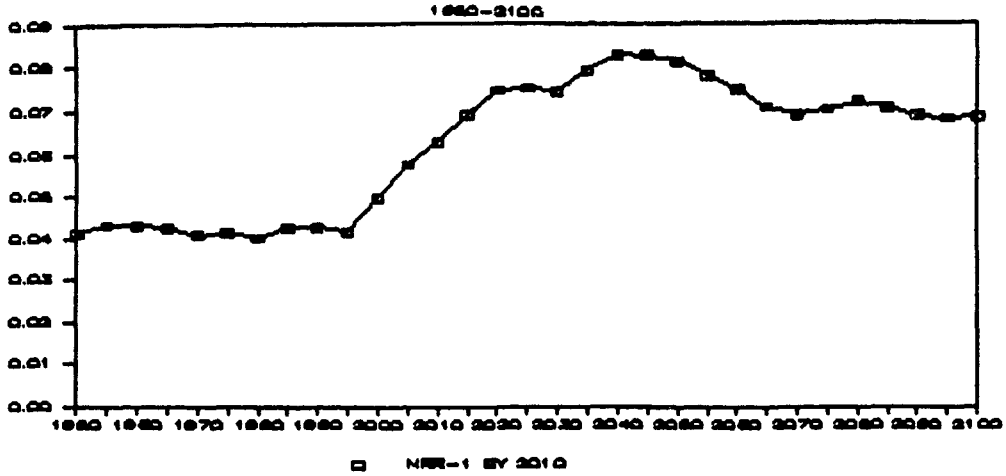


FIGURE 2

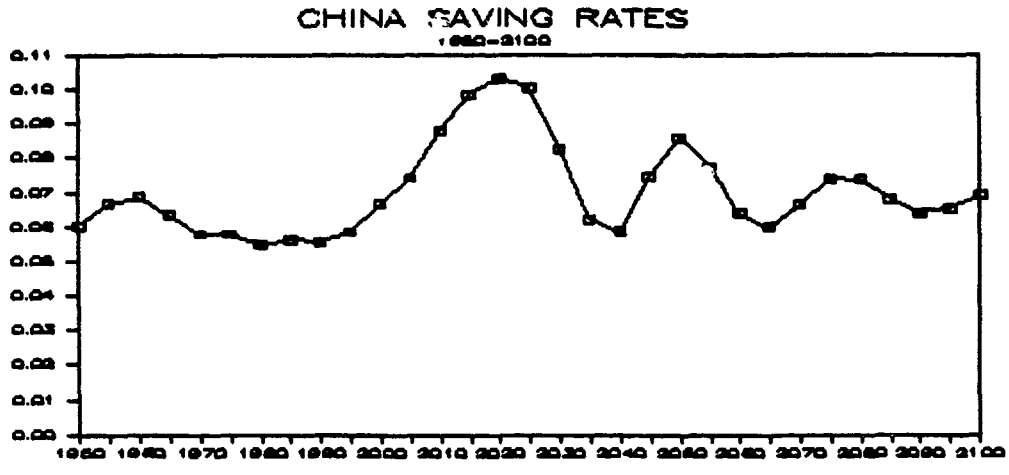

Path of Income, Consumption & Wealth
Typical Household
Income & Consumption Per Household
Total Y
Consumption
15 20 25 30 35 40 45 50 55 60 65 70 75
Consumption Per Capita
15 20 25 30 35 40 45 50 55 60 65 70 75
Wealth Per Household
15 20 25 30 35 40 45 50 55 60 65 70 75
Age of Head of Hou

FIGURES 3-5

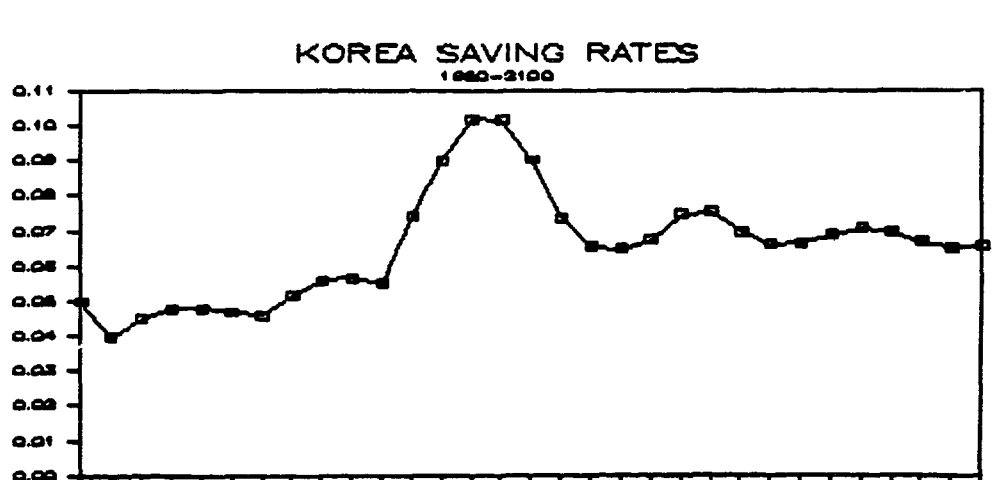
BRAZIL SAVING RATES



CHINA SAVING RATES



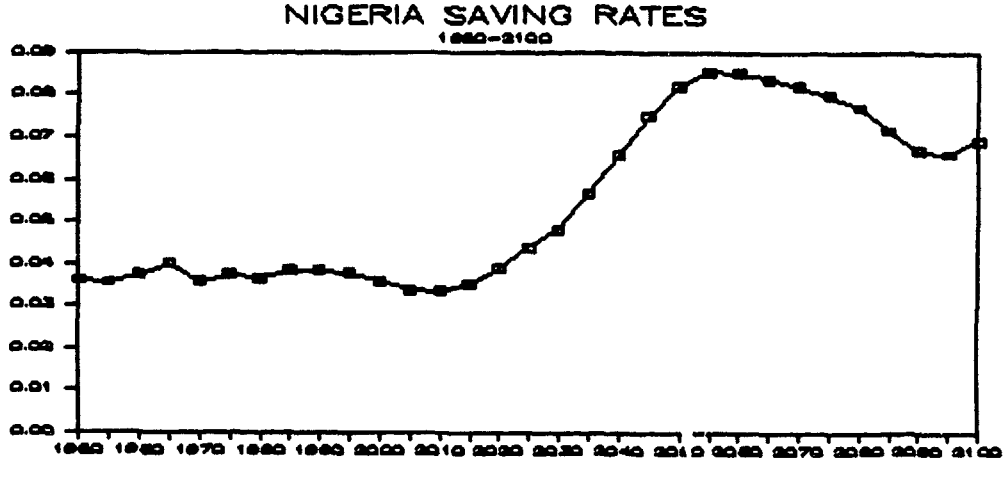
KOREA SAVING RATES



FIGURES 6-8

MEXICO SAVING RATES

NIGERIA SAVING RATES



PAKISTAN SAVING RATES

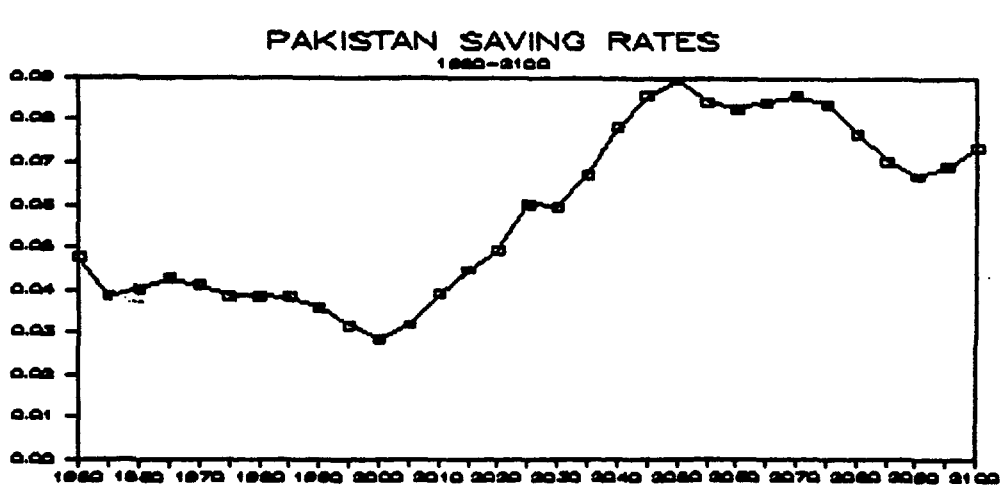


FIGURE 9

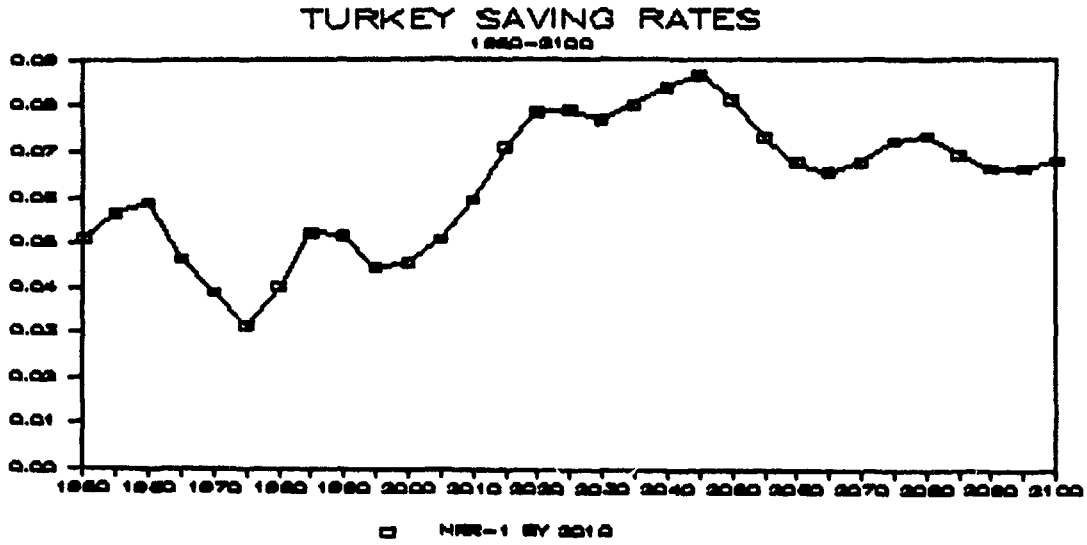

TURKEY SAVING RATES
1950-2100
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
NSR-1 BY 2010

FIGURE 10

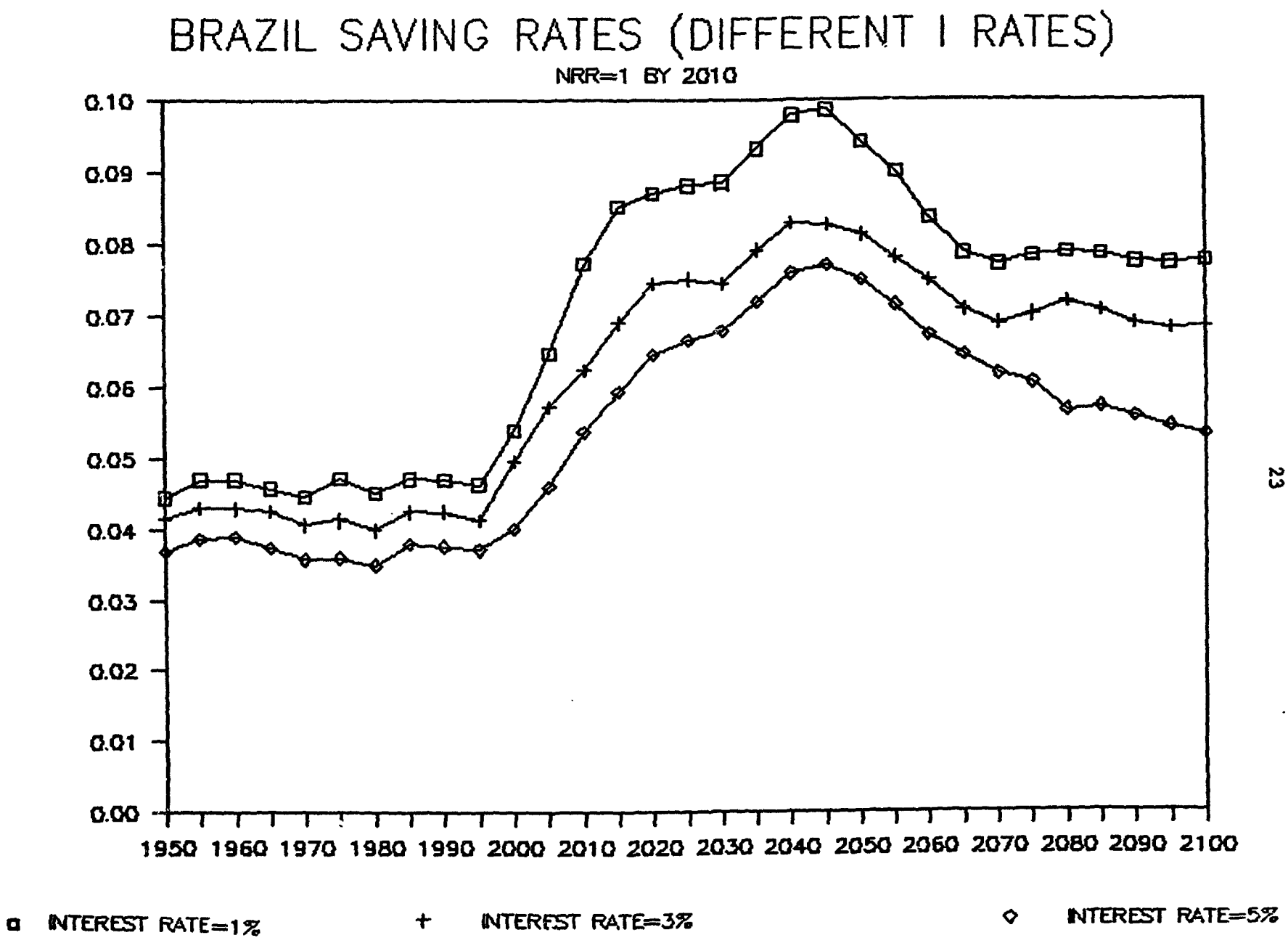

BRAZIL SAVING RATES (DIFFERENT I RATES)
NRR=1 BY 2010
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
INTEREST RATE=1%
INTEREST RATE=3%
INTEREST RATE=5%

FIGURE 11

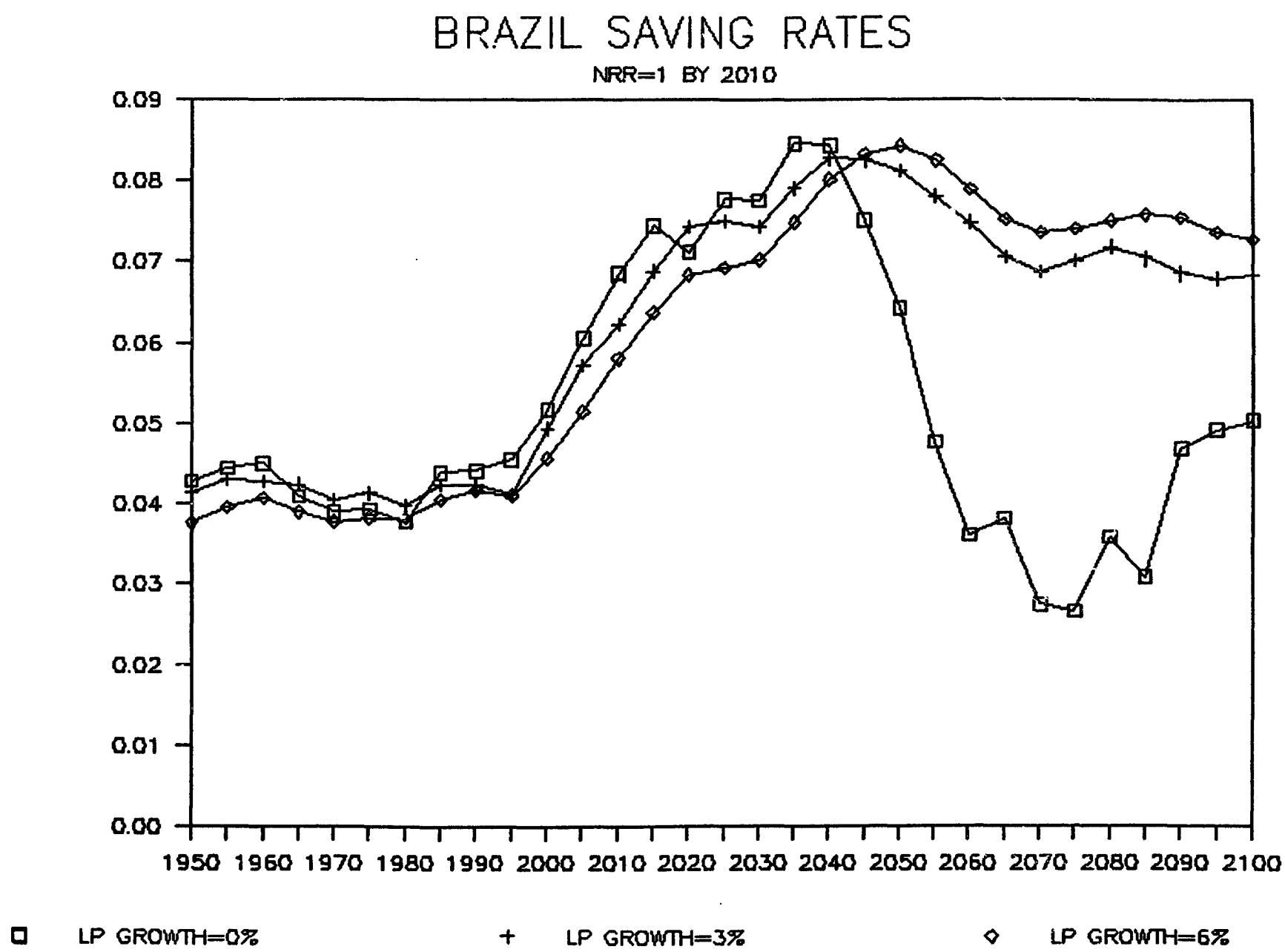

BRAZIL SAVING RATES
NRR=1 BY 2010
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
LP GROWTH=0%
LP GROWTH=3%
LP GROWTH=6%

FIGURE 12

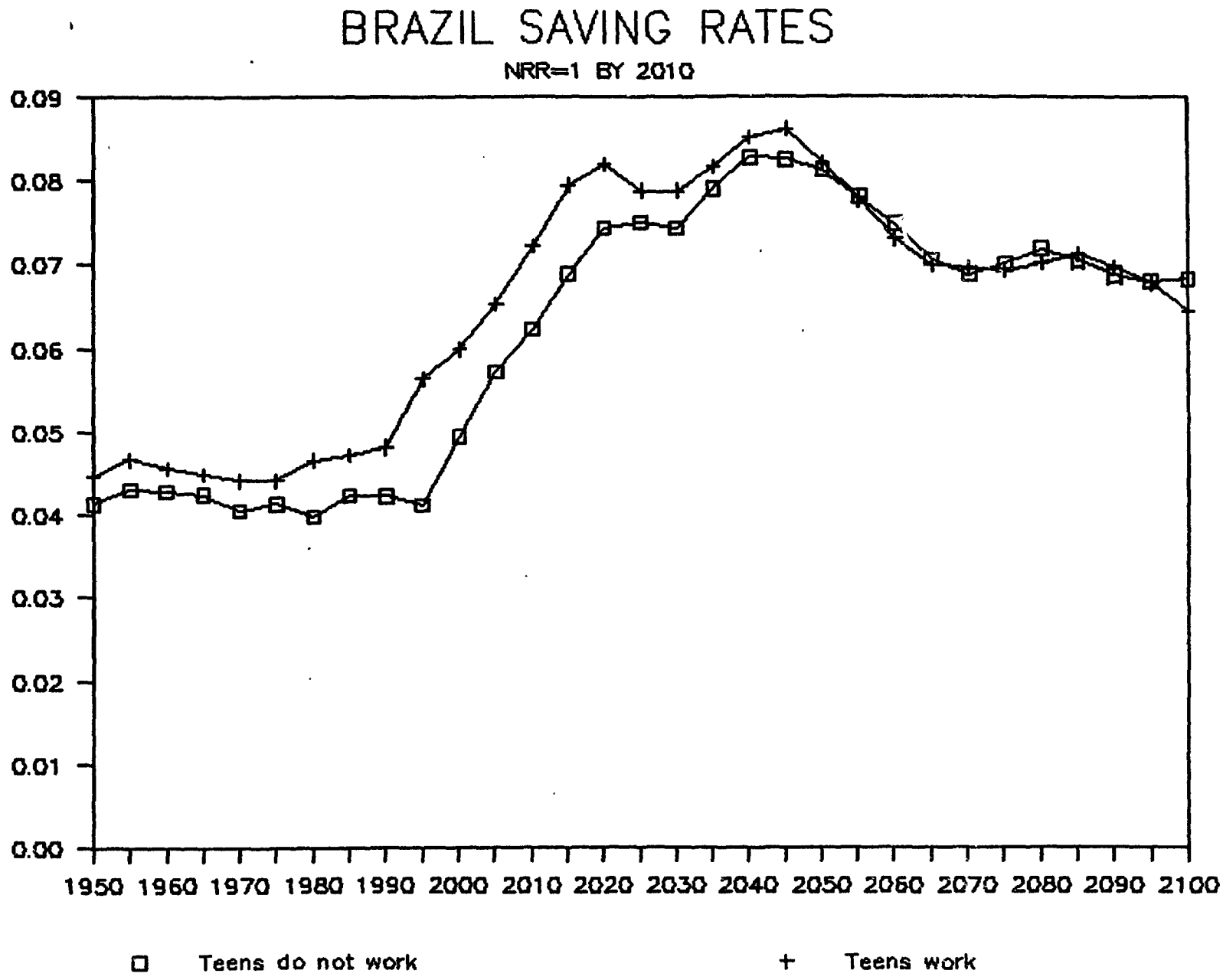
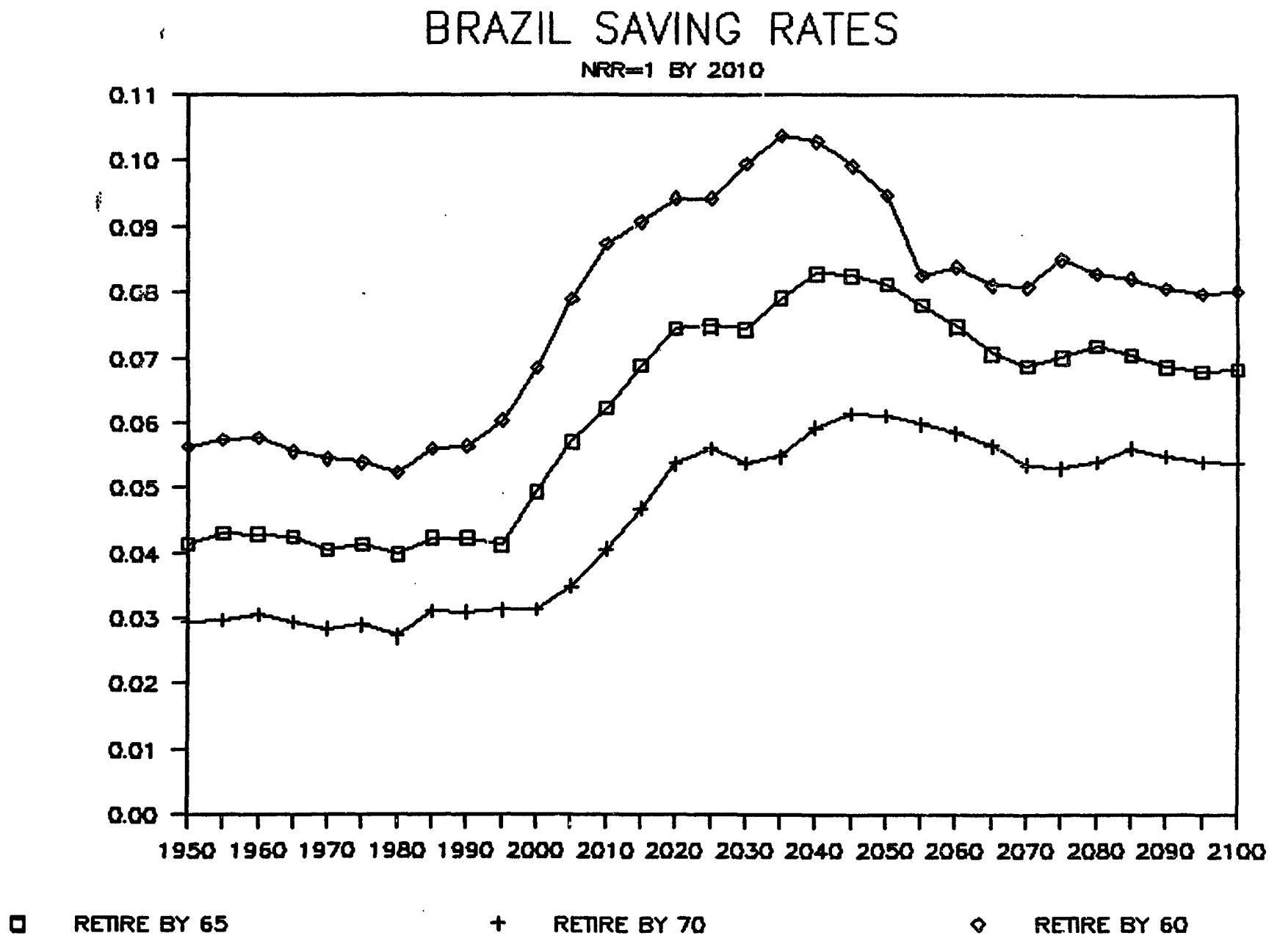

BRAZIL SAVING RATES
NRR=1 BY 2010
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
Teens do not work
Teens work

FIGURE 13


BRAZIL SAVING RATES
NRR=1 BY 2010
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
RETIRE BY 65
RETIRE BY 70
RETIRE BY 60

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